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SCHOOL PLANT AND EQUIPMENT

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Vol. XVIII, No. 1

February 1948

School Plant and Equipment

Reviews the literature for the three years ending December 1947. Earlier literature was reviewed in Volume II, No. 5; Volume V, No. 4; Volume VIII, No. 4; Volume XII, No. 2; and Volume XV, No. 1.

TABLE OF CONTENTS

Chapter	Page
Foreword	3
Introduction	4
I. Needed Research in the School-Plant Field.....	5
RAY L. HAMON, <i>U. S. Office of Education, Washington, D. C.</i>	
II. School-Plant Survey Technics	13
WILLIAM K. WILSON, <i>State Education Department, Albany, New York</i>	
III. Planning Procedures	16
CHARLES W. BURSCH, <i>State Education Department, Sacramento, California</i>	
IV. The Elementary School Classroom.....	22
CARL PAYNE, <i>State Education Department, Albany, New York</i>	
V. Planning the School Building for Community Use.....	28
DON L. ESSEX, <i>State Education Department, Albany, New York</i>	
VI. School Lighting	32
PAUL W. SEAGERS, <i>Indiana University, Bloomington, Indiana</i>	
VII. Heating, Ventilation, and Sanitary Facilities.....	37
I. O. FRISWOLD, <i>State Education Department, St. Paul, Minnesota</i>	
VIII. Trend in Materials and Design.....	44
HENRY L. BLATNER, <i>Albany, New York</i>	
IX. School-Plant Operation, Maintenance, and Insurance.....	52
NELSON E. VILES and NOLAN D. PULLIAM, <i>U. S. Office of Education, Washington, D. C.</i>	
X. Financing the School Plant.....	64
WILLIAM R. FLESHER, <i>Ohio State University, Columbus, Ohio</i>	

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FOREWORD

Two years ago the Editorial Board debated at length whether to include in the current cycle a review of research on the school plant. A casual survey of the literature indicated that research in this field had all but ceased. However, even tho the volume of research was dangerously near the vanishing point, the backlog of new school-building construction needed was mounting beyond anything previously faced in American schools and colleges. The decision, as this issue attests, was to maintain the series. The emphasis of this number is not as much on research accomplished, altho that is considerable, as on research needed. Here is a fertile field for those who will shape the new housing of American education.

Unfortunately the committee originally appointed to prepare this issue was unable to carry thru its assignment. At the last minute the committee was reorganized and Dr. Essex accepted the chairmanship. He was ably assisted by members of his staff. To the chairman, the members of his committee, and to the others who have contributed under pressure to preparing this issue, the Editorial Board is greatly indebted.

J. CAYCE MORRISON, *Editor*

INTRODUCTION

THIS is the sixth number of the REVIEW OF EDUCATIONAL RESEARCH dealing with the school plant. It covers the period from August 1, 1944, to December 31, 1947.

The committee has departed somewhat from the topic organization of the previous numbers. Needed research has previously been discussed at the end of each chapter. In this volume the first chapter is devoted exclusively to this subject. Because of widespread interest in recent years in planning the elementary classroom and in designing the school building for community use, chapters on these topics are introduced. There is no chapter on equipment. Other variations from the previous topic organization will be noted.

The committee recognizes that many of the references quoted do not represent research even in a broad sense of the term. This fact does not detract from the value of the volume as the school administrator or the school-building specialist will attest when he turns its pages for suggestions on various phases of school-building planning.

The past three years have seen an unprecedented amount of school-building planning. Members of the committee are all actively and busily engaged in some aspect of this work. That they have been willing to take time from their regular duties and in many cases to work extra hours in order to participate in the preparation of this volume is an indication of their devotion to their chosen field of work.

DON L. ESSEX, *Chairman*

Committee on School Plant and Equipment

CHAPTER I

Needed Research in the School-Plant Field

RAY L. HAMON

THE lack of scientific research and controlled experimentation in the area of school-plant facilities is appalling when considered in the light of a pending ten-billion-dollar plant program. Altho many factors have been partially determined by research and by expensive trial and error, there is an ever-growing need for additional research to determine desirable facilities for expanding educational programs and the best practices in the application of new materials and technics to educational housing.

Many materials, technics, and practices in the general fields of architecture, landscape design, construction, and furnishings are equally applicable to school plants. It is not necessary, therefore, that every feature of the school plant be a specific research subject. We can borrow many results of research from the general building field. In addition to general building features which are transferable to school plants, many aspects of general construction could be adapted to school use. Unfortunately, however, the entire building industry has been slow to apply scientific research methods to its problems. Research and progress in the building industry have not kept pace with the fields of medicine, transportation, and communication.

Even if adequate research results were available in regard to general specifications, engineering designs, and construction practices, and if such results were applicable to schools, there would remain thousands of unanswered questions as to space planning and plant tailoring to fit modern educational requirements.

During past years many suggested lists of school-plant research subjects have been published. Four are given here in their chronological order. Holy (3, 4), in two previous issues of *REVIEW OF EDUCATIONAL RESEARCH*, contrasted the lack of school-plant research with extensive research in other fields, and listed several phases of the school plant which need further research. The School Plant Research Committee of the American Council on Education (1) devoted a thirty-page study to the status of and the need for school-plant research. Brainard (2) pointed out the need for further research in the school-plant field, discussed some examples of specific research subjects, and proposed a program of action.

There has been some research on some of the subjects listed in the foregoing references. Many of the previously listed subjects are relisted herein, because there is still need for further and more fundamental research in these areas. The following listing is by no means complete, but the subjects are examples of some of the more important phases of the school-plant area in which immediate research is needed.

Acoustics

Sound control has become an important problem in schools, because of more informal school procedures and a greater use of nonsound-absorbent building materials. There are many acoustical materials available for many purposes. Research is needed to determine the amount of sound control necessary for various areas of the school building, and the types and amounts of materials required for satisfactory results in different areas. Some of the problems not yet satisfactorily solved are: (a) low-cost, fire-resistive acoustical material which will not require mounting on a fire-resistive base, (b) better means of mounting so the tile will not come off, (c) material which will not discolor with age, (d) repainting without loss of acoustical efficiency, and (e) a moisture-resistant acoustical material for swimming pool ceilings.

Codes

The effects of recently developed materials and designs upon the cost of construction should be carefully analyzed. There are, no doubt, increased costs entailed by following building codes which are in many cases obsolete. Some of this added cost for code compliance may be to protect entrenched interests rather than to protect lives and functional requirements. There is need for research as to design and materials that will reduce construction cost without impairing the functional value of the building or reducing the safety factor. Building codes and regulations should be carefully studied in relation to their present justification and their effect on building progress and costs.

Community Needs

The trend toward greater community use of the school plant is likely to continue. Community use of the school plant will vary according to the type of community and its needs and the availability of other community facilities. The area may be divided into several sections such as: (a) what are the present and future community activities for which physical facilities will be required, (b) which of these community activities should be accommodated in the school plants, (c) what types of community activities should be provided for in different types of schools, (d) determination of functional space and facilities for community needs to be met, (e) methods of planning facilities which will serve both school and community requirements, and (f) plant management problems when facilities are used by different agencies.

Financing the Plant

Research is needed to determine the relative merits of various methods of financing the construction of school buildings. More extensive samples should be used in projecting the division of costs among the different

types of building contracts and in setting up the over-all budget for financing a program of capital improvements, with breakdown guides as to relative costs of grounds, structures, and furnishings.

A careful study should be made of the apparent relative effectiveness of the various procedures and devices employed in campaigns for financial support. The results of such a study might be set forth in a campaign manual.

Functional Layouts

The first and most important factors to be considered in planning a school plant are the space requirements of the various areas and their relationships to each other. Areas cannot be determined until functional layouts have been made of each area, and the total plan cannot be developed without considering the affinities of the various areas of the building. These factors require the determination of room locations and dimensions. The architect cannot prepare even sketches until those responsible for educational planning have made these determinations. This is the weakest link in school-plant planning, because satisfactory procedures have not been developed for determining space dimensions and relationships. The situation is the result of the dynamic nature of education, and cannot be fully and permanently overcome. Research and careful analysis of educational programs and trends, however, should result in layouts which will be functional for a generation with but few alterations.

Some of the specific functional layouts for which research is needed are: (a) size and plan of elementary classrooms, (b) kindergartens, (c) facilities for separate primary units, (d) space for music and dramatics, (e) rooms for the teaching of core units in the secondary school, (f) recreational and dressing facilities for all pupils, (g) parents' room, (h) units for joint school and community use, (i) special community facilities, (j) provision for audio-visual aids, (k) shops for trades and industries, (l) space for general arts, (m) counseling and student activity rooms, (n) health facilities, and (o) administrative facilities for teachers, staff, and custodians.

There is need for further study as to plant flexibility for multiple use and future adaptations to changing requirements.

Furniture and Equipment

The chief need for study is related to the types, designs, and sizes of furniture and built-in equipment which will function effectively as educational tools in the various spaces of the school plant. Manufacturers have made some rather good guesses as to functional designs of furniture, with but little help from educators as to the functional needs and educational requirements of furniture for classrooms, laboratories, shops, and the many special and general areas of a school plant. Following are a few of the problems which have not yet been satisfactorily solved: (a) adequate

and convenient space for books, supplies, and cloaks; (b) picture projection equipment that can be moved and set up more easily and does not require darkening the room; (c) simplified practice of science furniture types to encourage the economy of pre-order manufacture; (d) multi-use equipment which will increase utilization and reduce over-all costs; (e) light-weight furniture which can be more easily moved by children; and (f) types of equipment needed in the various vocational areas.

Posture should be restudied to determine if present designs and sizes of furniture are satisfactory. There should be further research on lighter finishes of furniture, equipment, cases, and lockers so all manufacturers can establish their base prices on a generally accepted light finish. There is also need for further research on performance-test specifications to improve procedures in purchasing furniture.

Heating and Ventilating

There has probably been more research on heating and ventilating than on any other feature of the school plant. Altho there has been rather general agreement on desirable conditions, many codes are still based on false principles. The phase of the problem, which especially requires further study, is methods of achieving conditions which have been determined by research to be satisfactory. This is especially timely because of new technics for producing predetermined temperature, circulation, and air purity.

The following are among the principal subjects on which further research is needed: (a) panel heating installations which are satisfactory and economical for school use; (b) methods of installing and operating and the effects of germicidal lamps and other methods of purifying air; and (c) air changes, especially in toilets, laboratories, and kitchens. Recent studies have rather neglected humidity, and further research may be needed to determine to what extent humidity is important.

Insurance and Fire Protection

Property insurance practices have been materially improved during the past twenty years, but there is still need for vast improvements. More adequate coverage probably could be effected at reduced costs if research data were available on such items as: (a) current fire-loss ratios, (b) the value of extended coverage, (c) methods of calculating depreciation, (d) services received for commissions paid to local agents, (e) state insurance plans, (f) state purchase of blanket coverage allocated by individual local building risks, (g) methods of estimating present worth and insurable values, (h) desirable co-insurance percents for various risks, (i) the incidence of school fires, (j) state department of education participation in fire-safety programs, and (k) safeguarding school records.

Lighting (Conditions for Seeing)

There has been some research and a great deal of pseudo-research in the field of school lighting. The field is still very confused by conflicting opinions, commercial claims, and half-truths. The shift of emphasis from foot-candles to good seeing conditions has made much of the earlier lighting research obsolete. School lighting involves three factors which must be studied in their relationship to each and their effects on balanced brightness within the total visual environment. These factors are fenestration, surface finishes, and artificial illumination.

Following are some of the major subjects on which fundamental research should be undertaken: (a) types of window glass or window substitute materials; (b) amount and placement of areas designed as natural light sources under different climatic conditions; (c) furniture arrangements with respect to multi-lateral natural lighting; (d) shading and shielding devices for reducing glare from natural light sources; (e) colors and types of paints and other finishes on ceilings, walls, floors, furniture, and working supplies; (f) more effective shielding of artificial lighting sources without undue reduction of efficiency; (g) development of low brightness tubes in a lower price range; (h) eye tolerances to brightness and brightness differences, and establishment of standards of brightness balance for eye comfort and visibility; (i) determining differences, if such, between eye comfort and eye efficiency; and (j) study of the accumulative effect of unfavorable seeing conditions.

Maintenance of Plant

The following are some of the plant maintenance problems which need further research: (a) waterproofing, (b) masonry floor treatments, (c) interior and exterior painting schedules, (d) refinishing furniture, (e) treatment of rough interior wall surfaces, (f) refinishing rough masonry floors, and (g) repair schedules.

Maintenance Organization and Personnel

The general lack of adequate personnel and effective organization for plant maintenance calls for further research on such items as: (a) contract maintenance versus maintenance by regularly employed personnel, (b) use of school shop for repairs, (c) use of repair truck for minor repairs, and (d) the county school mechanic for rural school maintenance.

New Materials

There should be continued research on the use of the newer building materials now coming on the market. There will, no doubt, be unsupported claims for some of these new materials, and research will be required to determine the value for school construction. For example, the best grades of hardwood flooring are in short supply. The shortage will probably

continue and substitute flooring materials will have to be developed for various school uses.

Operation of Plant and Operational Personnel

The following phases of school-plant operation methods need further research: (a) nonwax floor treatments for rural schools, (b) smoke abatement with ordinary fuels and use of over jets, (c) boiler-water treatments, (d) surface deterioration from use of detergents, and (e) care of shop floors. Some custodial personnel problems are: (a) custodial unit time schedules; (b) custodial work loads; (c) custodial training procedures; (d) custodial employees' unions; (e) retirement benefits for custodians; (f) evaluation of operating efficiencies; and (g) employment, tenure, salaries, and management of custodial employees.

Records and Reports

More uniform systems should be established for recording and reporting property data. Distinctions should be sharpened among the classifications of plant operation, plant maintenance, and capital outlay. More uniform and meaningful methods should be devised for reporting plant values.

Sanitary Facilities

Further research is needed as to the number and location of toilet, washing, bathing, and drinking facilities. Requirements for these facilities have changed with modification in school programming, and will vary for different types of schools. Sanitary facilities represent a considerable investment, and their number, location, and design should be based on continuing research.

Sites

The trends toward more physical education, outdoor education, and community-centered schools all place increased requirements on the school site. Research is needed to determine areas adequate for these many and varied uses, and the best methods of laying out grounds for maximum utilization. Site size and location is also related to types of internal organization, grade grouping, and size of schools. Small primary units are growing in popularity in some cities.

Playground surfacing is a site problem which has not been solved satisfactorily for many types of soils. Facilities for storing and servicing yard tools and equipment need further study. Studies should be made of joint maintenance of school grounds and city parks to reduce costs and improve maintenance of both. Parking and bus loading and unloading have become serious problems. The parking problem is especially acute for colleges located in urban areas.

Further study should be given to types and quantities of playground

equipment. Much money is wasted on equipment which serves but little purpose. Site layouts and fencing should be studied in relation to buildings and streets for greater safety and convenience.

Need for Coordinated Research

Many institutions, agencies, and associations are interested in various phases of school-plant research, and some of them have made valuable contributions to the field. Some attempts have been made to coordinate school-plant research on a national scale, but these efforts have as yet been rather ineffective. There is no adequately financed central clearing house for collecting and evaluating research results, coordinating current and contemplated research, and determining and assigning needed research projects. There is a vital need for such a clearinghouse. The job cannot be done merely by expressions of willingness to cooperate and resolutions of good intentions by interested groups. Many talking conferences have been held on this subject, but worthwhile results cannot be expected unless and until competent individuals and institutions are assigned definite responsibilities and provided with adequate financial support for specific projects.

In addition to the cooperation of various school-plant research agencies, the best results will require close coordination in actual research projects. For example, research in acoustics, painting, illumination, and maintenance should be coordinated in a way which will recognize the interrelationships among these factors.

School-plant research should be a cooperative undertaking, but it will require coordination by a paid staff to achieve satisfactory results. Manufacturers must play an important part along with educators, architects, and engineers; but school officials hesitate to accept the results of research based solely on commercial interests. A full-time staff working under the direction of a board representing various groups and interests would probably be the best solution to over-all coordination of noncommercial school-plant research. Such a board might be composed of representatives from such agencies as: The American Institute of Architects, the National Council on Schoolhouse Construction, the National Bureau of Standards, the U. S. Office of Education, the U. S. Public Health Service, The Producers Council, the American Council on Education, and the American Association of School Administrators. It would be neither possible nor advisable to set up a central facility for all school-plant research. Specific projects would have to be assigned to specific individuals at institutions qualified to conduct the assigned research projects.

Such a coordinating agency would require substantial long-range support for a central staff, for institutional direction and scholarships, and for necessary research equipment and materials.

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CHAPTER II

School-Plant Survey Technics

WILLIAM K. WILSON

IT is difficult to define as research, technics for determining school-plant needs, if research involves both development and testing of methods. Recommendations evolving from a school-plant survey are based upon long-range predictions and estimates of trends in population, enrolment, educational methods, practices in educational administration and organization, and in methods of financing education. Testing this accuracy of long-range predictions on any of these factors involves time far beyond the three-year cycle of the REVIEW OF EDUCATIONAL RESEARCH. It is possible, however, to point out some new or improved technics for predicting or estimating fundamental data and conditions that may result in sounder recommendations for the expansion or improvement of school-plant facilities.

The problem of school-building needs is paramount today. Thousands of studies of need are being made, ranging from statewide surveys to individual studies of small rural districts. Practically every one of these studies involves predicting enrolment, predicting the distribution of children within the areas studied, evaluating the existing school plant, relating the school plant to the educational program and organization, and estimating the ability of the district to finance capital expenditures.

The following report on technics used in recent school-building surveys indicates some worthwhile and perhaps new approaches to four important factors of a school-building study, as follows: (a) the philosophy given as a basis for encouraging districts to prepare long-range studies of school-building needs, (b) the methods of predicting enrolment, (c) the method used in arriving at a complete picture of the ultimate long-range school plant, and (d) the method used in determining the recommended number and locations for buildings in the long-range plant.

The Philosophy of Long-range Planning

Reavis (4) traced the history of the gradual development of long-range planning of school plants, first pointed out examples leading to the present-day widespread activity and interest in such planning. He emphasized the need for providing authoritative answers to at least six questions when evaluating any given building of a school plant. Briefly, these six questions cover the items of safety and health, relation of the building to the educational program, operation and maintenance cost, flexibility for future change, the character of the school site, and the artistic effect of the building on children and community.

Strayer (5) outlined four factors necessary in studying the buildings and grounds of a school system, as follows: evaluation of the school buildings, studying population and enrolment trends, basing recommendations for need on the utilization of the existing facilities, and setting up steps for the development of the complete school plant. Under each factor general sources of material were cited.

Wilson (7) discussed the advantage of long-range planning and outlined the method of such planning under five steps: outlining the ideal school plant necessary to do that job, evaluating the existing school plant, setting up the practical plant expansion program thru the adaptation of the usable existing facilities to the ideal plant, and setting up a schedule for the orderly development of the ultimate practicable school plant.

As an argument for satisfactory school-plant facilities, Carpenter (2) set up the objectives of education in a "Code of Rights." He developed the following five principles to be followed in the planning of school-building facilities: health and safety, planning for flexibility in meeting changes in education, determining the best use to be made of existing facilities, consideration of beauty and dignity of a school building, and characteristics of the school site. He also listed fourteen types of information that should be collected in making a school-building survey.

Bogner, Cotton, and McLeary (1) discussed the need for and development of long-range planning and set up five requirements: developing the plant in terms of the educational program, considering the possible changes of the future educational program, planning the buildings and facilities for expansibility, overcoming the inadequacy of the existing facilities in terms of a complete educational program, and determining financing in terms of actual building needs.

Predicting Enrolment

Wilson (8, 9) developed a technic for predicting enrolment from recorded births by analyzing the trend over a period of years between resident births and enrolments accruing from those births. This ratio was then used for predicting future enrolments from the latest recorded resident births.

Developing the Ultimate Plant

In arriving at the final recommendation for the locations of the buildings in the ultimate school plant, Wilson (6, 8, 10) introduced a factor not heretofore used. In his surveys he used three terms: the existing school plant, the ideal school plant, the ultimate school plant. In the ideal school plant, the locations of all buildings determined as to type and desired capacity are located ideally without regard to restrictions on possible actual locations. Then, following the evaluation of the existing plant and

the determination of the best uses to be made of the units of this plant, the ultimate school plant was developed as an adaptation of the usable existing facilities to the ideal school plant.

Determining the Number and Location of Buildings

Wilson (6, 7, 8, 10) developed a method for determining the number of elementary buildings in the ultimate school plant by using an optimum enrolment range for each school, and by determining thru zoning data the approximate area of residential land needed when saturated to provide the number of children within that range. Natural barriers and acceptable walking distances for children were contributing factors in the method. It is claimed that this method eliminates the necessity for accurate prediction of total elementary enrolment over a given period of time. The method was used also for junior high schools in the New Haven Building Survey. Engelhardt (3) used this method successfully in a survey of elementary and junior high school needs for Northeastern Queens, New York City.

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CHAPTER III

Planning Procedures

CHARLES W. BURSCH

THE planning, financing, and construction of an adequate and appropriate school plant is educationally important, very complex, requires large sums of money, and takes months or years to consummate. There is a substantial body of literature dealing with the subject. However, it has been and is today devoted principally to *what* should be found in a school plant and *how* it should be financed. A portion of the literature deals with procedures in planning. It is concerned with devices for improving and controlling the processes necessary to give reasonable assurance that the many desirable participants have made their full contributions and that the facilities chosen by them will actually appear in the completed building. It is with this portion of school-plant literature that this chapter deals.

Current emphasis upon the functional aspects of school-plant planning and upon the desirability of having each plant "tailored" to the specific educational program to be housed therein creates the necessity for following a carefully planned and detailed procedure. So does the presence of an increasing number of legally constituted plan-review and approval agencies. Also the subdivision of architectural and engineering services into many specialties emphasizes the practical necessity to the school administration of control procedures. Each specialist should do his part but should not unbalance the whole enterprise by overemphasis of his specialty.

City-School Districts

The basic principles, as well as specific recommendations for each school, resulting from the planning procedure adopted by Detroit, Michigan, were reported by Browe (1). A highly significant procedure for broad public consideration of and participation in their building survey report of the Cincinnati public schools was cited by Holy and Herrick (19). Changes in tentative recommendations brought about because of public participation were listed. Steps adopted by board of education resolution to implement the survey recommendations established a procedural pattern which involved provision of additional staff, the setting up of staff committees, and the routing of committee responsibility thru the superintendent of schools.

The Manual of School Planning for the City of New York (30) contained a division on planning procedure which designates routing of information, plans, and decisions, and defines in detail what is to be included in required documents. Another New York City document on Operation-Maintenance Requirements for School Buildings (31) had a twelve-page

section dealing with procedure upon the completion of a new building.

The extent of effective joint planning between large city-school districts and community-planning bodies was reported by Grieder (17). He also described the machinery of cooperation found in some of the cities studied. Long (23) described staff committee organization and procedure in participating in building planning in Portland, Oregon. Analysis of community background data and involvement of school staff, community leaders, and a competent architect was recognized as important in the planning process by Church (8). How a school-building program is handled in Cleveland, Ohio, was discussed by Murphy (28).

Frequent meetings of a survey committee with groups of teachers and other interested citizens of the parish were found by White and Smalling (41) to help in solving building planning problems. Engelhardt (9) pointed out how the preparation and continuous revision of a building manual for a school district serves as a focal point for assembly and organization of the complex and ever changing materials pertinent to school planning and construction problems and procedures.

State Departments of Education

Some state departments of education have emphasized planning procedures both as a means of improving school plants and facilitating legally required approvals. The New York State Department of Education (32) stressed the importance of a cooperative study of local needs and periodic participation by the Division of School Buildings and Grounds thruout the planning period, defined thoroly preliminary drawings, unfinished working drawings and final working drawings and specifications, and stated how each stage was to be presented for review and approval.

Carpenter (6) stated principles that should govern the development of a building program, listed types of information to be assembled, and included a checklist designed to facilitate the following of important items from the recommendation stage thru preliminary plans and then into the final plans. His statement of precautions to be observed in voting bonds is quite complete.

The Michigan State Department of Education (25) in two chapters clarified the relationship of the state to school-building projects and gave detailed information on the conduct of a building program. The Minnesota State Department of Education (27) organized its material on planning procedures in a similar manner. The Oregon State Department of Education (33), under the chapter heading "Procedures in Planning School Buildings," stressed planning steps, architectural services, sources of planning information, need for community participation, and common procedural errors to be avoided. Similarly the West Virginia Council on Schoolhouse Construction (40) dealt with planning a school-building program and the California State Department of Education (5) docu-

mented agreement by parties officially concerned on basic planning considerations prior to authorization for the architect to begin production of final drawings and specifications. Wanamaker (38) explained how the Washington state aid for school construction program was worked out cooperatively on a long-term basis. Grieder (16) found that an organized pool of consultants drawn from the universities and colleges in Colorado was able to render complete and disinterested planning services to school districts at low cost.

General Studies

Devoted completely to procedure is the bulletin by Strayer, (37) dealing with planning for school surveys. This bulletin is the type of service instrument designed to assist a school administrator, not familiar with survey practice, to conduct a thoro survey of his schools. Marshall (24) developed twelve steps designed to be of assistance in many school-plant planning situations. He emphasized the need for each school to develop its own planning schedule. The necessity for school-building adaptations to accommodate changes in educational programs is emphasized by Engelhardt (10). He outlined planning steps to guide boards of education in effecting the desirable changes.

The factors to be considered by a schoolboard in developing a plan of action in regard to plant provisions or improvements was presented by Perkins and Cochran (34). Foy (14) gave twelve suggestions on how to proceed in planning school buildings but emphasized that each community must develop its own formula. Eleven steps in planning were developed by Flesher and Holy (13) for assistance to communities that wish to proceed with a thoro study of their school-building needs. Kimes (21) emphasized the need for careful organization of the planning process so that the school administrator can better discharge the heavy responsibility involved.

Holmes (18) undertook to assist school administrators understand the school-plant planning problem as a comprehensive whole by means of a complete and practical outline with comments. Procedures designed to accomplish orderly progress, wide participation, and critical evaluation of each step in planning school buildings were outlined by Lewis (22). Engelhardt (11) gave ten categories of problems associated with planning building programs. He illustrated the discussion of categories with maps, diagrams, and floor plans. The detailed plan of how the regional planning commission of Los Angeles County cooperates with school districts in the selection of school sites was described by Bursch (2).

Because the problem of planning school buildings is beyond the competence of any one individual, Miller (26) assigned the role of coordination to the superintendent of schools and specific areas of planning to others having specialized competence. A significant report of the planning pro-

cedure used for a specific school plant was made by Kilham (20). Bursch and Reid (4) devoted almost an entire book to the procedure of administering a planning and building program of a school district and encouraged school administrators, planners, architects, and engineers to find original solutions in terms of local situations thru independent and creative thinking. The National Council on Schoolhouse Construction (29) stressed the process of school-plant planning as a cooperative undertaking involving many persons. Twenty steps in planning school-building programs were developed by Gregg (15) as a means of giving assurance that capital outlay funds would be well spent and to assist in making the building planning program continuous. The considerations necessary to produce a community type school plant were discussed by Sohn (36). He especially stressed the relationship of school planning to zoning authorities and to the development of the neighborhood concept.

How integration of the contributions of many persons and groups was achieved to produce a functionally designed school building was reported by Fawcett (12). Whitehead (42) explained stages of work in educational planning preliminary to plant planning, with special reference to the place of educational consultant services. How orientation of a school superintendent and an architect to the complex problems involved in planning a high-school swimming pool could be accomplished was reported by Chastain and Weihe (7). Weaver (39) recommended the use of scale models of equipment results in superior shop layout arrangements. His suggestions and illustrations made use of that method practicable. Bursch (3) pointed out the importance of the local school-plant staff composition, organization, and assignment in assuring that appropriate facilities are provided. His ten-point program of action and conclusions stressed the need for improving planning procedures and control technics as the most promising basis for fulfilment of the school superintendent's responsibility in the school-plant field.

Summary

A substantial number of experienced school-plant personnel have published their ideas on planning procedures. A much smaller number have reported evaluations or results of the procedure. There is evidence that many school districts, especially those in the larger cities, have not published descriptions of the planning procedures they are using. It can scarcely be doubted that the publication of such reports would facilitate progress in school-plant planning.

Of even more value at this time, however, would be the production and publication of more reports of the type done by Seagers (35) in his dissertation. In this study he gave sufficient procedural detail to be of real assistance to those who embark seriously upon a program involving many planning participants. He also gave substantial attention to the question of values accruing because of wide participation.

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CHAPTER IV

The Elementary School Classroom

CARL PAYNE

THE elementary classroom is the first school home of children embarking upon the school career. Because of the invaluable and lasting impressions of first experiences, there is a growing feeling that more attention should be given to planning this room. Very little research of a formal nature is available to substantiate the idea that recently constructed elementary classrooms are more effective in providing a better basic educational program. There are, however, many opinions that much progress has been made in the thinking of what constitutes a good elementary classroom.

Simon (28) and Engelhardt (10) pointed out that the problem of housing children for educational purposes is a human problem concerned primarily with the child. Simon (28) stated that younger children present the more intensified problem because of the importance of first impressions in a child's development. Engelhardt (10) indicated that when teachers plan classrooms to meet their needs and those of the children, the teachers will be challenged not only to improve the physical environment but also to consider the philosophy of education and the effectiveness of the whole teaching process.

General Features of the Elementary Classroom

According to Engelhardt (10), certain aspects of the planning process, such as human relationships and the design of a classroom in terms of all aspects of child development, are usually ignored. Perkins (25) reported that the child should be prepared to live happily and the classroom should give him adequate tools with which to learn. Ramsey (26) concluded that there is no such thing as a wholly desirable classroom as the human element insures that no classroom will ever meet perfectly the needs of all the persons who will use it thruout the years.

It is apparent that classroom standardization is fast decreasing. Reavis (27) thought that the feature of school buildings presenting the greatest problem in functional planning is the classroom. He attributed the excellence and the rapidity of progress in school construction to functional planning. Sutherland (29), Wilson (33), and Ramsey (26) opposed any standardization in classroom size. Wilson (33) stated that the elementary-school plant was generally in poorer condition than the secondary school. He condemned the practice of turning the old high-school plant over to elementary use. Ramsey (26) pointed out that the ideal classroom should possess flexibility.

The Department of Elementary School Principals and the Research Divi-

sion of the National Education Association (20) sent out a questionnaire to a random selection of twenty-five principals and sixty-three classroom teachers in 1945 to find out what building facilities they believed should be provided for a modern elementary-school program. The report indicated that the most desired item was increased classroom space. More outdoor play and recreation area and additional and adequate storage space of different kinds ran a close second. Many of the teachers and principals expressed an opinion in favor of separate toilet facilities for each room and a sink with hot and cold water in each classroom.

Ramsey (26) discussed the advantages of first floor location for elementary classrooms. Baxter and Bradley (3) pointed out the influence of environment upon the effectiveness of the elementary program. Heffernan (13) found that no field of educational endeavor has shown greater progress in recent years than that of creating improved educational environment.

Size and Shape

Perkins (25) discussed the elements determining classroom size and arrangement. The inadequacy of the traditional elementary classroom was pointed out by Otto (23). He stated that the classroom need not be rectangular. There is considerable agreement that the elementary classroom size should be increased. Lieuallen (16) found that thirty square feet per pupil is the minimum amount of required space, exclusive of wardrobes or cloak rooms. Elsbree (9) recommended from twenty-six to thirty square feet per pupil for those elementary grades above the kindergarten and forty square feet per pupil for the kindergarten. Simon (28) suggested a minimum width of twenty-six feet for the elementary classroom. Sutherland (29) omitted any recommendation of specific class size. He is opposed to any standardization in classroom size.

Features and Equipment

A separate workroom was recommended for all primary classrooms by Otto (23). He advocated a separate room designed as a laboratory for art, handicraft, and science for the intermediate grades. Ramsey (26) suggested a workroom with such special features as an elevated floor for occasional use as a stage and sound-proof curtains. *The American School Board Journal* (2) described the equipment and special features of a work alcove. Fawcett (11) discussed a project room for use by elementary children, both primary and intermediate. He found that sliding glass doors separating the project room and the main classroom shut out noise and enabled supervision.

Beard and others (4), Hosler and Swanson (15), and McClure (18) recommended direct access to the outside from the classroom. Beard and others (4) advised ramps to ground level instead of steps. Ramsey (26)

found that the adjoining outdoor classroom is gaining in popularity because the development of certain skills and knowledge is impossible in the indoor classroom.

Heffernan (13) pointed out the advantages of having the outdoor terrace adjacent to the classroom on the same level as the classroom. She advocated a shelter to enable greater use of the outdoor area adjoining the classroom, pointing out the health advantages of outdoor study and play. Begg (5) described the Manhattan Beach School in California where one entire side of each classroom is glass-framed in steel. A wide sliding steel and glass door can be opened so that the classroom includes an adjoining individual terrace. He found the close relation of indoors and outdoors extremely successful in the warm climate.

Marsh, Smith, and Powell (17) recommended an outside work terrace of cement. Payne (24) suggested asphalt or similar surfaces for some portion of the play area to permit play out-of-doors following a shower. It is generally agreed that play areas adjoining elementary classrooms should have some turf area, and some asphalt space. Beard and others (4) recommended some space for planting.

The Michigan State Department of Public Instruction (19) recommended pupil's project storage as a necessity in the elementary classroom. It found that the need for the large general storage is lessened when elementary classrooms are provided with sufficient cupboards and shelving. Nichols (21), Elsbree (9), Credle (8), and Lieuallen (16) favored project lockers or cubicles. Credle (8) described the optimum size for storage chests and discussed the best location for them. *The American School Board Journal* (2) reported that recessed cabinets and modernly constructed bookcases provided adequate storage space in a primary school when cupboards in the cloakroom were available to the pupils as well as to the teacher. Beard and others (4) recommended storage space under window seats in classrooms housing children from four to seven years of age. Elsbree (9) found advisable a narrow counter with adjustable shelves constructed along the wall under the windows.

The American School Board Journal (1) reported the use of the classroom wall adjoining the corridor for a vented wardrobe, a teacher's supply closet, built-in files, and storage shelves. The Michigan State Department of Public Instruction (19) found ventilating corridor lockers good in some elementary schools. Elsbree (9) pointed out the necessity of either lockers, a wardrobe, or a cloakroom for each classroom. *The American School Board Journal* (2) indicated that individual numbered locker boxes with a continuous built-in bench below, running the length of the walls, were in satisfactory use. Ramsey (26) pointed out that lockers outside of the classroom were a substitute for cloakrooms.

The American School Board Journal (1) found separate toilet rooms for boys and girls in the elementary classroom advisable. Hosler and

Swanson (15) indicated a preference for adequate centralized toilets for the primary school. McClure (18) found that the washroom and toilet room located off the work alcove an efficient arrangement. Otto (23) indicated that the individual toilet room was preferred, with the possibility of a separate toilet room for boys and girls above the third grade. Beard and others (4) reported that one toilet room for boys and one for girls for all classrooms from grade one thru grade six was the choice of many elementary teachers. Tallman (30) advised special toilet facilities for each of the several grade levels—kindergarten, primary (1-3), and upper grades (4-6). Fawcett (11) described the elementary classroom that had a common toilet for boys and girls leading off the clothing room. Elsbree (9) noted that toilet facilities in the primary classroom probably have their greatest usefulness in grade one.

Credle (8) and Vincent (31) recommended a lavatory and a drinking fountain for each elementary classroom. Begg (5) described the Manhattan Beach School which was equipped with a sink in each classroom. *The American School Board Journal* (2) described a primary school that had work alcoves equipped with a sink adjoining each cloakroom. Ramsey (26) included a drinking fountain and a sink as essential equipment for each classroom.

Hosler and Swanson (15) found that a stage in one end of the kindergarten was of value when the room was used for community purposes. Sutherland (29) pointed out that movable partitions in a modern classroom assist the school to adapt itself to the changing needs of teaching. Cappa (7) indicated that the trend is toward less chalkboard and more display space. *The American School Board Journal* (1) described a front wall of a classroom equipped with reversible tack and chalkboards of the easel type and swinging chalkboards. It pointed out that light cream color for chalkboards had some advantages.

Built-in work benches with shelves underneath were recommended by the Michigan State Department of Public Instruction (19). Knee-and-toe room were advised, and wall cupboards and tool racks over the benches were recommended. Hamon and Smith (12) pointed out that the types of equipment should be determined early in the planning so that proper electric outlets, drains, gas and water lines, chalkboards, and bulletin boards could be properly placed. McClure (18) indicated that work alcoves should provide space for workbenches and sandtables.

Bruner (6) advocated twenty running feet of bulletin board space at least four feet high. Otto (23) recommended some built-in shelves, closets, and drawers. He pointed out the possibility that there has been too much built-in equipment and advised the consideration of book shelves on wheels, thus permitting greater flexibility of use within the classroom.

Wiley and Wiley (32) indicated that there is a demand for furniture that is more effective in carrying out the program of the modern school

and is functional from the standpoint of the needs of the growing child. Movable furniture was advocated by Nichols (21), Begg (5), McClure (18), Lieualen (16), and Fawcett (11). Nichols (22) discussed those aspects of planning that are peculiar to the nursery schools, largely disregarding those common to all school buildings. Ramsey (26) advocated that children's sizes should determine the height of all facilities such as sinks, cabinets, blackboards, pictures, and so forth.

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CHAPTER V

Planning the School Building for Community Use

DON L. ESSEX

FOR years educators have been advocating that the school plant be designed to provide not only for the educational needs, but also for many, if not all, the social, civic, recreational, and cultural needs of the entire community. It is felt that if this can be done, in many instances inefficient utilization of public buildings and duplication of costly building materials can be avoided. Furthermore, it seems certain that as the school and community draw closer together, interest in and support of the regular school program by the community increase accordingly.

Notwithstanding this widespread interest in planning the school building for community activities, few writers in the field of school-plant planning have come to close grips with the problem. That is, there is very little literature on *how* to plan the school building for community use.

The most ambitious attempt to define and describe the community school plant was undertaken by Engelhardt and Engelhardt. (3) Their volume deals primarily with large school districts and is centered around adult activities. Many illustrations of rooms and other plant areas planned for various types of community activities are given, and examples of communities which have organized programs of community interest which are housed in the school building are discussed. This book is helpful to large, fairly wealthy districts, but has only narrow implications for relatively poor rural communities where the school building may be the only public building in the community.

The New York State Department of Education (18) was concerned primarily with rural school districts and pointed out that few if any additional facilities over and above those commonly found in a well-planned school building are needed to take care of the usual community activities. Many rooms can be used dually by both school and community. Five factors must be given careful consideration: (a) location in the building of facilities used by the community, (b) distribution of heat for unit and room control, (c) provision for adequate storage space for equipment, (d) special appointments and service features, and (e) provision for toilet facilities.

Perkins and Salmon (19) agreed that regular school facilities can be used for community affairs and said that special rooms for community purposes are a luxury. Regarding extra costs involved in planning a school building for community use, Essex (5) emphasized that separate plants to take care of community needs would be a far more costly proposition. Hamon (8) drew plans for a small community-elementary school building

and called attention to the following features: (a) multipurpose room; (b) large stage; (c) kitchen for school lunches, community suppers, and homemaking; (d) handicraft room; (e) library; (f) health room; (g) gate to close off classroom portion of building; and (h) work counter, storage, and display board space in each classroom. McCharen (15) said that the school library should be a vital part of neighborhood life and discussed the planning of the library for both school and community use. Engelhardt (2) said that every community should provide its own list of common problems and concentrate on those not cared for by community agencies.

Schott (20) listed the adult organizations having activities which can properly be housed in the school building, and developed a measuring device for evaluating a "community service area" school plant. This device contains no items that are peculiar to the planning of a school plant for community use.

Food Service and Preservation

Marshall (14) reported that food service for community affairs can be offered without extra facilities being provided.

The National Council on Schoolhouse Construction (16) listed four general types of food service facilities: (a) complete preparation, service, and dining facilities planned for table service; (b) complete preparation, service, and dining area planned for cafeteria service; (c) kitchenette type of food preparation, but dining provided for in the classrooms, assembly room, gymnasium, or other area which is used during the major portion of the day for other purposes, and (d) central food preparation for several school lunch departments in school systems with facilities for serving and dining in each school. Credle (1) pointed out that the community school is the logical location for the community cannery, the food dehydration plant, and the quick-freeze unit.

School-Community Recreation Programs

Hjeite (10) listed three elements in school-community planning for recreation: (1) neighborhood playground—usually served by an elementary school, used mainly by children; (2) district recreation center—a constellation of neighborhoods, including such facilities as swimming pool, picnic ground, gymnasium, large athletic field, batteries of tennis courts; (3) regional place of recreation—beach, lake, wooded area, etc. as schools ordinarily have no facilities of this character to offer. Essex and Miles (6) pointed out that school recreation facilities must be specially planned for community use if they are to serve the dual role economically and adequately. Graff (7) suggested two divisions of "grounds": one type controlled by other community agencies, but available to the school; the other, under the complete administrative control of the school.

The National Recreation Association (17) suggested dual use of many rooms, such as kindergarten rooms for glee clubs, drama clubs, orchestras and the like; assembly hall for indoor baseball, basketball, and volley ball. Gymnasiums, auditoriums, homemaking rooms, shops, music rooms, libraries, cafeterias, teachers' rest rooms can be taken over for recreation with little change beyond the addition of storage closets. The Association also listed the following rooms as essential for a good school-community recreation program: quiet game room for cards, parchesi, chess, checkers, etc.; active game rooms for basketball, punching bag, Indian clubs, etc.; billiard and pool room; lounge; reading room; check rooms.

The Neighborhood-Primary School

With the extension of the school program downward to include pupils of nursery school age and with the increase in traffic hazards, particularly in congested residential areas, much attention has been given during the past two years to the planning of neighborhood-primary schools.

Hosler and Swanson (11, 12) pointed out that the neighborhood-primary school brings home and school closer together; may be made an integral part of and serve a comparatively small homogeneous residential area; can be less institutional in size, scale, and program than the traditional school; and that, with automatic heat control, a matron may be used instead of a man custodian. They described a proposed neighborhood-primary school building for Allentown, Pennsylvania. Hart (9) recommended small neighborhood-primary schools for ages five to seven located at strategic points a distance of three, four, or five blocks from large elementary schools. These would be one-story buildings, containing from four to six classrooms with low ceilings and window sills, having few accessory rooms, and located on small sites. Engelhardt and Huggard (4) described this type of school as a home-school unit for nursery, kindergarten, first- and second-grade pupils, and pointed out its value as a community center.

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CHAPTER VI

School Lighting

PAUL W. SEAGERS

THE chapter on school plant lighting by Gibson (6) in the February 1945 issue of the REVIEW OF EDUCATIONAL RESEARCH is still one of the best sources of information today on school-plant lighting. The quality of light as determined by a balanced brightness is receiving more attention than any other phase of lighting at this time. However, higher levels of intensity are being used, with the National Council on Schoolhouse Construction (15) recommending twenty to forty foot-candles depending upon the type of activity.

Logan (14) went back to nature to determine comfortable seeing conditions. He divided the entire field of vision into six horizontal zones and by means of a flux meter he was able to determine the distribution of light in those zones. He said that research has shown that the eyes work with the field of view as a unit and, therefore, engineers should treat it as a unit. Harmon (8) took issue with Logan and some other engineers and said that to produce efficient vision and comfortable seeing, the illuminating engineer must be concerned with more than quantities of light and distribution of these quantities. He must be concerned with qualities for given tasks based on sound visual physiology for that task. He must know the total physiological effect of the light media with which he is working. He must plan for today's efficient seeing in terms of tomorrow's ocular comfort as well. He must not be a mathematical manipulator of the physical media for producing light, but a human engineer in the field of visually centered activity. The Harmon technic of classroom lighting, as it was set up in the Rosendale School in Austin, Texas, was described in an article by Whitcomb (22).

Daylighting and Classroom Lighting

A number of technics in providing visual comfort and efficiency in the classroom have been either tried or advocated thruout the country. Haskell (9) recommended sixteen ways of daylighting a classroom, among which are the sloped ceiling and louvered awning and the directional glass block. Paul (18) wrote a book in which he described the use of a directional glass block and attempted to show that the brightness of that block at practically all positions of the sun is well within the recommended tolerated brightness. Wright (23) suggested bilateral lighting with clerestory windows on one side. He also suggested fourteen-foot ceiling heights, four-foot window sill heights, fixed louvers of metal for all windows, high reflection factor paint on the window sides, 80 percent reflection factor paint on the ceilings, 55 percent to 60 percent reflection factor on the walls and 40 percent reflection

factor on the floor, furniture, and woodwork. He would eliminate all glass panels in doors leading from classrooms directly out-of-doors to reduce brightness contrasts in the room. He suggested also painting blackboards and chalkboards to harmonize with wall color.

Allphin (1), in setting up an illumination experiment in a Massachusetts school, attempted to reduce the sky brightness at forward angles. He selected appropriate colors with high reflection factors and had the lights monitored by a pupil who had a special lighting indicator fastened to his desk. This lighting indicator was a simple light meter with a special face which hid the needle when the meter was receiving an approved amount of light, but which became visible when there was not enough natural light in the classroom. Gibson and Sampson (7) emphasized that the schools need a visual environment that makes "seeing comfortable, easy, and fast." Areas of either high or low brightness should be kept to the smallest area practicable. If they cannot be eliminated or corrected they should be kept as far from the line of sight as possible. Bieseke (2) stated that it is desirable that the average brightness of the visual task be slightly greater than, but not more than, three times as great as the balance of the central field. He said that artificial lighting systems must fulfill the same requirements as the natural lighting systems; therefore, there should be enough light on the work to provide satisfactory brightness levels, and brightness ratios in the field of view should be within the same limits.

Darley (4) thought that the provision of seeing conditions in the classroom should not be predicated upon the needs of tough, normal eyes, but upon those of the most sensitive and defective eyes in the group. He said that some of the common complaints about the higher intensities furnished with fluorescent lighting is not due to the fact that there is too much light but from the high disturbing brightness ratios within the field of vision of the individual. Bursch and Gibson (3) said that natural light is not superior to incandescent or fluorescent light for critical seeing purposes. The kind of light, within the common limits of natural or daylight and artificial light from incandescent or fluorescent lamps, has no significant effect upon the seeing process. The important thing is not how much light is striking the task but how much light is being reflected back from the task.

Brightness Ratios

James (13) paid particular attention to the brightness ratios thruout the entire visual field. He also showed that altho fluorescent fixtures are very expensive they consume at least 40 percent less electricity than incandescent for the same illumination level and, therefore, over a period of approximately ten years, the over-all costs of illumination by fluorescent fixtures would be approximately that of incandescent fixtures. Neidhart (17) said that the lack of proper illumination has a profound psychological

effect upon children. Children cannot be blamed for not liking school if their classrooms are dingy with dark woodwork and drab walls. Drudgery can be taken out of school work in bright cheerful surroundings. He suggested the use of a semi-indirect luminaire which directs about 60 percent of the light upward and 40 percent downward. The Illuminating Engineering Society (12) discussed the comfort-discomfort threshold and furnished a table which compares the actual brightness of light sources with the established tolerable brightness of these sources and also goes more fully into brightness ratios.

Principles of Good Lighting

Altho there have been a large number of applications of the principles advanced in the material reviewed above, only four outstanding applications have been selected for this chapter. The lighting of the offices and library of the Harvard School of Business was one of the better applications. It was described by Holway and Jameson (10). The research group in charge of this demonstration set up a list of work rules as follows: first, all sources of glare should be eliminated; second, the lighting should be distributed evenly over working surfaces and as far as possible thruout the entire room; third, the quality of light should be such that it is neither unpleasant nor uncomfortable over long periods of visual work; and fourth, the amount of light falling on the working surface should be of the order of 20 foot-candles. Another outstanding example of proper applications of good lighting principles is given in the report of a two-year study made jointly by the Public Buildings Administration and the Public Health Service under the direction of the Federal Works Agency, Washington D.C. (5). For this study the environment of a card punch subsection of the Bureau of Internal Revenue was changed by bringing up to the proper light reflection factors the ceiling, walls, furniture, equipment, and floors of the room. Studies were then made of the percent of errors of the employees, the turnover of employees, and the psychological effect of the new environment. New fluorescent lighting was added, which gave not only a higher intensity of illumination but a much better general distribution.

Putnam and Anderson (20) discussed the application of good lighting principles to the rehabilitation of classrooms at the East Cleveland, Ohio, and Cleveland Heights, Ohio schools, as well as selected schools thruout the United States. Their pictures and descriptions of before and after rehabilitation are excellent. They also set up a comparative cost analysis for lighting new school classrooms, as well as for relighting existing classrooms. Putnam (19) showed the application of good lighting principles to drafting rooms at the Case School of Applied Science. The need for a higher general level of illumination and the reduction of reflected glare is especially significant in drafting rooms.

Among the general pamphlets on lighting schoolrooms, two are outstanding. The first is *Teaching about Light and Sight* published by the National Education Association (16) and the second is a more technical but easily read pamphlet, *On Lighting School Rooms* published by the U. S. Office of Education (21).

For all technical information concerning illumination the *I. E. S. Handbook* (11) is an authoritative guide.

Summary

Intensity—Most research agrees that the intensity of lighting at desk level in classrooms should lie somewhat between 20 and 30 foot-candles.

Quality—1. Luminaire brightness: The brightness of the luminaire should come well within the range of tolerated brightness for that particular fixture and the room it is to be installed in, as found in the tables of the *I. E. S. Handbook*. 2. Brightness balance: There should be a maximum ratio of 3 to 1 between the task and surroundings; 10 to 1 between the task and remote surfaces; 20 to 1 between luminaires or windows and adjacent surfaces; and 40 to 1 anywhere within the normal field of view. This calls for ceilings with the reflection factor of at least 85 percent, walls 60 percent, wainscoting and trim 40 percent, floors and furniture 30 percent to 40 percent, and chalkboards at least 20 percent.

Daylight Control—Many efforts have been made to control the daylight in the classroom and give a better over-all distribution of natural light. Bilateral and clerestory lighting as well as the use of a directional glass block, baffles, screens, outriggers, and other equipment have been used successfully under certain conditions. At the present time they are not recommended for all situations.

Maintenance—Regardless of the type of illumination a poor maintenance program will unbalance the illumination in any room. A good checking and maintenance program is a must for all schools.

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CHAPTER VII

Heating, Ventilation, and Sanitary Facilities

I. O. FRISWOLD

DURING the period covered by this review, the most noteworthy developments in heating, ventilation, and sanitary facilities appear to have been (a) the publication of the New York State Education Department heating and ventilation recommendations, (b) widespread interest in radiant (panel) heating, and (c) reports dealing with the study of airborne infection. Altho a great deal of space has been devoted to heating and ventilation, the attention given to sanitary facilities in the literature of this period has been negligible.

New York Heating and Ventilating Recommendations

Essex (14) described how New York State in 1940 amended its ventilation laws to require merely that plans for any school construction project should not be approved by the commissioner of education unless provision was made in them for heating and ventilation facilities adequate to maintain healthful and comfortable conditions in the classrooms and study halls.

The most complete report of the New York action was presented by the State Education Department (41). This report contains a discussion of the physiological and psychological objectives involved in providing a satisfactory thermal and atmospheric environment, standards of performance, and methods of attainment. The regulations needed to implement the new statutory requirement were adopted by the Board of Regents on November 16, 1945. They specify design operative temperatures and corresponding room air temperatures to be met for various types of space or levels of activity, a maximum air temperature gradient of 5°F from floor to sixty inches above floor, and that air velocities in zones of occupancy shall not exceed twenty-five feet per minute. Where schoolrooms are used in summer, air-cooling equipment may be required.

Ventilation, "atmospheric hazards and quality," provisions are as follows:

1. In classrooms, a minimum air change of ten cubic feet per minute per occupant. For effective thermal operation in mild weather a design factor of fifteen *cfm* is desirable.
2. In rooms planned for close assembly, a minimum air change of ten *cfm* per occupant shall be provided in order to remove odors. Additional air change, depending largely upon wall exposure, may be required for effective thermal operation in mild weather.
3. In rooms where there is danger of toxic substances occurring in large concentrations or where odors are likely to be strong or where overheating is

likely to occur, special ventilating equipment, adequate to relieve the situation and entirely independent of the ventilating system serving the rest of the building, shall be installed.

4. With plans and specifications, a brief, clear, and nontechnical description of the heating and ventilating system together with instructions for operation are required.

The regulations are aimed at two objectives: (a) to provide proper thermal conditions, and (b) to eliminate odors and toxic substances from the atmosphere. Relative humidity is regarded as relatively unimportant. Recirculation of air is considered to have no value except to preheat a cold unoccupied room. Air disinfection is regarded as important but it is felt that at this time no recommendations can be made or standards set for controlling air-borne infection for lack of adequate reliable data.

Radiant (Panel) Heating

A great deal of attention has been given to radiant or panel heating in technical and nontechnical publications during the period covered by this review. Only a sampling of the less technical references can be mentioned here.

Alyea (2) presented an overview of what radiant heating is, how it works, its advantages, types, problems of design and control, and how ventilation may be provided in connection with this type of heating system. Kump (31) among others described applications of this system to school buildings. The advantages and disadvantages of radiant heating, and comparisons between this and other systems of heating have been treated by several authors. Hayes (18) described radiant heating briefly and enumerated some of the advantages claimed for it. Bursch (7) presented the opinions of sixty-five school architects regarding the use of radiant panel heating. He reported that the trend in California is toward this type of heating for school buildings. Druse (13) suggested that the emphasis on radiant heating has created the erroneous impression that other heating methods will soon be obsolete. Lewis (34) pointed out that warm air as well as steam or hot water is a carrier of heat that can be employed in radiant heating systems. The advantages of radiant base boards (20, 29) appear to be warmer floors, greater cleanliness, lower under-ceiling temperatures, elimination of drafts, reduction in fuel consumption, and full utilization of floor space as compared with small tube cast-iron radiators installed in open recesses under windows. Robertson (44) enumerated the advantages of electric radiant heat which he maintained is economically practical on electric rates of one cent per kilowatt hour.

It is of interest at this time, when the application of radiant heating to school buildings is receiving so much attention, to learn that the earliest true radiant heating system thus far found in this country was installed in the floors of a two-story, four-room schoolhouse in Glen Parks, a town which is now part of Gary, Indiana (10, 20).

Control of Air-Borne Infection

According to the *American Journal of Health* (3) the control of air-borne infection presents a broad new field of environmental sanitation that may prove as important to human health and welfare as has the control of disease-producing bacteria in milk and water supplies. Answers are being sought to two basic questions: (a) In what places, and under what conditions, is the problem of droplet nuclei of sufficient importance to warrant specific programs of control? and (b) Where control of microbic content of air seems desirable, what methods are most effective and most economical?

Mudd (36) presented an excellent overview of current issues and the available evidence revealed by a study of seventy-two references dealing with various aspects of air-borne infection. He attacked the argument that the elimination of respiratory infection is undesirable because it may make people "immunologically soft"; supported the thesis that the money costs of preventive measures shrink to comparatively trivial figures compared to what it costs to leave air-borne infection uncontrolled; and advanced the conclusion that the means, consisting of ultra-violet radiation, dust-suppressive measures, and the use of germicidal vapors of hypochlorous acid and of propylene and triethylene glycol, were at hand to render air safe for human occupancy.

The *Journal of the American Medical Association* (25) reported that the amount of air-borne infection is greater than it was formerly believed. Experimental studies conducted by or for the army and navy during the war years such as those reported by Wheeler and others (52), and Bigg, Jennings, and Olson (4, 5, 24), all produced encouraging evidence that air-borne infection can be controlled in some measure. However, a cautious, critical viewpoint regarding the effectiveness with which air-borne infections can now or have been controlled was expressed by the Commission on Air-Borne Infection (11) and the National Research Council (37).

Dust serves both as a carrier of pathogenic bacteria and viruses and as a shield of air-borne pathogens from destruction by ultra-violet radiation and germicidal vapors, according to Mudd (36). Air samples collected by Buchbinder and others (6) in six New York City schools indicated that the average number of bacteria in the air was largely influenced by the amount of dust that was present. Harris (16) maintained that the only effective way to remove fine particles, less than one micron in diameter that constitute 80 to 90 percent of the total particles suspended in the air, is by electrostatic precipitation which has proved successful in the Layden Community High School, Franklin Park, Illinois.

Successful results in using ultra-violet radiation in elementary schools in Swarthmore, Pennsylvania was reported by Morey (35) and in Cleveland, Ohio, by Hodges (23). Wells (51) reported recent data from the

Germantown Friends School and the Swarthmore elementary-school experiments that indicated that ultra-violet radiation in classrooms reduced the spread of chickenpox, measles, and mumps to susceptible pupils. Seagers (47) described in detail the important studies of ultra-violet lighting now in progress and projected at the New York Cato-Meridian Central and Port Byron Central schools and presented the tentative conclusions reached on the basis of this experiment to date. Perkins and others (43) also reported on this experimental study. The results were promising but not conclusive, and further experimental investigation is needed to ascertain satisfactorily the effectiveness of ultra-violet irradiation and other methods to control air-borne infection in a school environment. Pleasantville, New Jersey, was reported (22) as the first community to have embarked on a three-year communitywide test of the use of ultra-violet rays to disinfect the air inhaled by school children. Yates (53) claimed that forced ventilation caused an increase in the absences of high-school pupils due to respiratory illnesses.

Factors in Body Health and Comfort

Seagers (46) pointed out that the comfort and health theory is concerned with (a) relative freedom from air-borne infections, injurious chemicals, and dust; (b) motion of air; (c) temperature; (d) humidity; (e) draft sensation; and (f) removal of odors. Nelbach (38) presented a well-organized summary of current best thought regarding standards for school heating and ventilation and suggested that the expression "thermal and atmospheric conditioning for schools" be used in place of the term "school heating and ventilation."

Gilmer (15) described the psycho-physiological principles of bodily temperature adjustment and the mechanism of the skin that operate in the perception and control of body temperature changes. Keeton (26) and Tasker (48) joined in this discussion, and called attention to earlier studies and reports of body temperature sensitivity and control. Adlam (1) maintained that the concept that warm ambient air is necessary for thermal comfort is fundamentally wrong. Rowley, Jordan, and Snyder (45) reported that variations in relative humidity from 35 to 60 percent did not cause any change in the feeling of comfort of office workers, but Leopold (32) supported the validity of the effective temperature index.

Nesbitt (39) reiterated his views regarding standards of adequate ventilation in terms of maintaining acceptable odor and effective temperature levels in classrooms, and the advantages of unit ventilation in maintaining such standards; Nesbitt (40) also maintained that heating and ventilating standards generally accepted as essential for schools can be met only by mechanical methods. Yates (53) listed disadvantages and presented data to make a case against forced ventilation.

Miscellaneous Topics and Trends

Otis (42) described the origin of the "unit" system and the progress made in its design and application. He maintained there is no need to provide special provisions for venting air from classrooms equipped with unit ventilation, and dismissed objections to corridor venting as a fire hazard. Others (19) offered objections to corridor venting. Hatch (17) presented a list of fourteen safeguards in the installation and operation of ventilating systems to eliminate fire and smoke hazards.

Clancy (9) described the heat pump, or reverse cycle refrigeration, for heating buildings in winter and cooling them in summer. Kemler (28) discussed the advantages and limitations of air, underground water, and the earth as heat sources. Tucker (50), as did Kemler (27), presented a review of the general information now available and suggested additional studies and laboratory work that are needed to permit the rational design of heat sources for reverse cycle refrigeration.

The use of heating coils to melt snow on surfaced playground areas, loading platforms, walks, and driveways seems to offer possibilities that school officials in northern climates should investigate. Krueger (30) advocated electro-thermal space heating, and Lewis (33) and the editors of *Heating and Ventilating* (21) presented their ideas of heating and ventilating systems for the school buildings of the future.

Sanitary Facilities

Cannon (8) collected the opinions of architects and schoolmen regarding the sanitary fixtures preferred for postwar schools. Corrigan (12) scored the neglect of toilet room housekeeping and supervision and lack of concern for forming good pupil handwashing habits in schools. Treanor (49) urged schools to provide adequate handwashing facilities and opportunities for pupils to use them.

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CHAPTER VIII

Trend in Materials and Design

HENRY L. BLATNER

THE past three and a half years have produced marked progress in the conception and design of the school plant. The urgent need for educational facilities, the necessity of economical planning, and an increased emphasis on function rather than tradition have all focused attention on a new and exciting design philosophy. It was quite encouraging to note the informal, friendly type of building which came into prominence at the expense of the more rigid, monumental type of structure commonly erected to serve as a school building. Great emphasis has been placed on safety, child scale, satisfactory illumination, and flexible arrangement of the component parts of the schoolhouse to permit joint use of the entire project by children and adults alike, either separately or simultaneously.

There was a marked tendency toward proper cooperation between the educator and architect to produce schoolhouses which would further the educational program of a school district rather than serve as a questionable monument to either or both of the parties involved. Such a tendency has been aided by high costs and scarcity of building materials. The ingenuity of the designer has been taxed to the utmost in order to produce adequate educational facilities for the maximum number of children within minimum budgets. Therefore, applied and extraneous decoration, excessively expensive materials, and antiquated thinking fortunately have been relegated to the past so far as most schoolhouse planning is concerned.

In the field of pure research, however, there appears to have been a paucity of sincere, scientific effort. Possibly the work of Harmon (11) represented the broadest research undertaken during this period. He continued basic studies previously begun in Texas, using 160,000 elementary-school children in the public-school system as objects of study. He and his staff paid particular attention to the matters of posture and daylighting relative to over-all bodily development. They charted the physical condition of many children over a period of years and concluded that poor posture and inadequate daylighting were major contributory factors to excessive body stress, fatigue, deformities of varying degree, and low performance standards. Twenty-four experimental centers were established in Texas for studying improvements in schoolhouse furniture, natural and artificial illumination, brightness control, and color correction. The Harmon studies were unquestionably a major contribution to the advancement of schoolhouse planning and design. One should be careful, however, not to be lulled into the belief that any one method is the correct or ultimate answer to the basic problems involved. There continues to be a wide

difference of opinion among educators, architects, and scientists as to the validity of certain standards which have been established. Independent research free from commercial flavor is an urgent need.

Notable, also, was the exhaustive study made by Paul (26). His work covered natural illumination and its component problems and was based primarily on the use of prismatic glass block of certain manufacture. He approached the daylighting problem with proper emphasis on low brightness contrasts and integrated design for better illumination. Complete data concerning the natural lighting of a hypothetical classroom of defined dimension with a unilateral panel of prismatic glass block was developed and compiled. Using an artificial light source to simulate the sun in conjunction with a scale model of the hypothetical classroom, important information relative to sun angles and light intensities was recorded in efficient form. He showed that use of prismatic glass block provided a step forward in the field of natural illumination. It must be noted again, however, that this study proposed one particular method and one particular material for classroom daylighting. The data might well be employed by architects as a useful tool rather than as an accepted method without further thought or research.

Materials

The anticipated revolution and drastic change in postwar building materials did not materialize altho such a possibility was envisioned by several writers. It was discouraging to note that contemporary production technics were not applied to construction methods in general. However, such technics were applied to the manufacture of building materials and offset excessive installation costs to some extent. One significant development was the introduction of modular design. The history and development of this design was reviewed by Lorimer (19). He pointed out the possibility of lower building costs thru use of standardized integrated dimensioning and manufacture of materials and equipment. The technical problems and proposed solutions connected with modular design and coordination were illustrated by Adams and Bradley (1).

Pearson (27) traced the influence of materials of construction thruout the history of building and pointed out the liberation of architectural form thru the invention of steel. He noted new and novel materials and methods such as plastics, rustless metal alloys, prefabricated building and parts of buildings. Re-examining the use of older materials such as marble, wood, and glass, he noted that they are now being designed for mass production and broader general use rather than for the custom type of production and design used heretofore. He concluded that contemporary, functional architecture is trying to use the machine age to develop new forms and that the outstanding feature of this particular period is a growing interest in the more intelligent application of materials in order to improve our structures.

Severud (35) displayed a keen sense of the use and propriety of reinforced and architectural concrete and envisioned distinct advantages which might be expected thru the use of concrete. Higgins (15) discussed the place of steel in school-plant construction and noted several advantages to be gained thru the use of steel as a load-supporting medium. He touched lightly on the intriguing subject of the rigid frame principle of design which has direct application to all types of schoolhouse structures. Popkin (30) reported an interesting use of adobe as a structural material in a school-building program in the southwest. Plummer and Wanner (29) explained reinforced brick masonry and its application to schoolhouse construction.

Essex (9) reported considerable increase in the use of plywood, asphalt tile, and reinforced concrete but concluded that revolutionary changes in school-plant construction were not yet at hand.

Vallin (39) referred to new materials and methods but felt that they would provide better ways of achieving existing effects rather than drastically change our present concept of material and texture. Included in the discussion were breathing walls, impregnated woods and plywood, paints, lacquers, and other equipment. Creighton (7) noted the increased use of glass in varied form, particularly glass block and insulating glass, and explained the advantages and disadvantages of various types of glass.

Cannon (5) reported the results of a survey conducted among administrators and architects relative to materials preferred for use in schools. Smith (36) evaluated and charted various materials suitable for interior wall and partition surfaces. He illustrated the nice balance required of a material in order to achieve the multiple advantages of low cost, low maintenance, light reflection, acoustical benefit, and flexibility. Linn (18) made a similar study of flooring materials while Schwarz (34) assembled data on acoustical treatment.

Design

The majority of writers agreed that the desirable schoolhouse would be one designed from the inside out. All parties concerned with educational facilities seemed to agree that the trend toward objective buildings is the correct trend. Scientific planning appears to have overcome the hurdles of sentimentality and tradition. This attitude was reflected by Bursch and Reid (3) and Haskell (13) who discussed the desirability of extended architectural services to include long-range planning. Mentioning reports and surveys to cover population trends, housing trends, future sites, and transportation, they recommended that these serve as the basis for an intelligent, flexible master plan. They advocated such a plan to guide present and future schoolboards in evaluating individual schoolbuilding requirements relative to the full contemplated program. Essex (9) wrote that many have come to believe the successful school plant should be

designed in a functional, informal manner to achieve the best results and that such a building is usually more economical than the traditional, formal structure. He noted that the movement from traditional to contemporary design is a west-east movement across the country.

Haskell (14) reported an advance in basic standards during 1946, the increase of one-story school designs from west to east, and the use of open corridors in areas of moderate climate. Wurderman and Becket (41) erected an example of the extended one-story type of structure so favored in the far West. Sutherland (38) argued against standardization in order to best serve student groups with varying degrees of ability and speed of learning. He noted that the true purpose of an educational system is development of the individual and that such a program demands school plants which are most flexible. Kump (17) prepared a very interesting set of sketches illustrating free planning of the modular type consisting of several buildings coordinated by means of open, covered walks and courts. While applicable primarily to moderate climate, this conception was an inspiring one and worthy of study.

Several writers were concerned lest there be insufficient thought and study on the part of each school district inasmuch as each individual program and environment differs from others. For example, Englehardt (8) stated emphatically that one of the least constructive acts is to copy the school plan of another community. He felt that contemporary design assumes safety, sanitation, and comfort as a matter of course and that only as the schoolhouse achieves the position of an inspirational and educational center can the work of planning be considered successful.

Anderson (2) pointed out the danger of patterning one school building directly from another and the danger of schoolboards' holding out for preconceived plans merely because they were successful elsewhere. He stated the oft-repeated axiom that schools must be designed from the inside out and noted the importance of organic design which relates building to site culturally as well as architecturally. He contended that a school plant reflecting utilitarian values, artistic proportions without extravagance, and an understanding of the immediate locale would be a great stimulus to the culture of an entire community. He also noted that the architect has an exceptional opportunity to create an environment when designing a new school building.

Nichols (25) cautioned against any particular style of building as such. He compared the archeological, romantic approach which he considered lifeless with the self-conscious modern approach which often might be insincere or the desire for just something new. It is doubtful, however, that this comparison indicated a full understanding of the friendly, selfless type of building which most informed people preferred. In his observations was sensed a hesitancy in breaking with the past, a reluctance to clear the way for intelligent, uninhibited planning.

Vincent (40) explored the problem of functional school building and noted twelve basic considerations of school planning.

Multiple Use and Expansion

Great stress was laid upon the design of school buildings for multiple use. Essex (9) indicated the trend toward joint school and community planning and observed that few additional facilities were needed beyond the usual ones in order to fulfil joint requirements.

Clapp and Perkins (6) summarized the reasons for and problems involved in planning for multiple use of school-plant facilities. Matson and Matson (21) described the stirring possibilities of an educational program which might be attained when proper meeting of the minds of educator, social worker, and architect is reached. They envisioned the extension of the educational facilities of a community to include those of neighboring communities, thus providing for exchange of ideas, broadening of horizons, and new friends.

Smith (37) discussed the necessity of flexibility and provision for expansion in the school plant. He believed these factors of prime importance due to the establishment of higher and more definite standards in every area of education, the increase in importance of the elementary, vocational, and agricultural type of school building, and the increased adult use of school buildings. Melby (22) pointed out educational requirements while Haskell (12) illustrated several solutions for these requirements. Both stressed the desirability of functional, multi-use planning.

Design Factors

It is interesting and important to note the effect on school design which may be attributed directly to a careful consideration of lighting. In addition to the research efforts of Harmon (11) and Paul (26), there were found studies indicating differences of opinion on the basic premise of whether or not daylight is the ideal source of schoolroom illumination.

Kaelber and Waasdorp, Wheeler and Will (16) presented an interesting study which compiled the average and probable number of "sun hours" in four widely separated American cities. Using their findings, they illustrated plans and sketches for a school building wholly dependent on an artificial source of classroom illumination.

Wynkoop (42) contradicted the use of artificial light as the main source of illumination. He illustrated the direct effect on school-plant design and appearance which results automatically from an intelligent consideration of natural light source.

Lyndon (20) achieved a noteworthy child scale and a pleasing atmosphere in his sketches and proposals for a California school. It is indicative that such a result grew from original thinking based primarily on a well-conceived method of daylighting. A comparison of this study with the

work of Rich and Conn (32) illustrated two extremes in the contemporary approach to and appearance of buildings published concurrently.

An equally important design factor is the question of one-story versus multi-story school buildings. There was noted a definite trend toward one-story buildings by observing both recently completed and proposed structures. Arguments in favor of one-story buildings were safety, better natural lighting possibilities, child scale, and economy thru use of non-fireproof construction. Arguments in favor of multi-story construction were based mainly on economy of land and construction.

Cannon (4) noted as the result of a survey conducted among architects and educators a preference for two-story, basementless buildings. Fawcett (10) described and illustrated a well-conceived, open plan type of one-story building based on a thoro survey of the needs of an entire community. It is questionable whether or not the clear thinking applied to the building program was compromised by the exterior appearance.

Priault (31) illustrated a sprawling, one-story school plant. Saarinen and Swanson (33) achieved a well-organized, friendly one-story building. Yet Pence (28) described a new two-story high-school building which received an unusual amount of thought so far as program requirements and site planning were concerned.

In the opinion of Miller (24) school districts with semipermanent structures (which infers one-story) will have less hesitancy in following new trends than those districts with more permanent and costly buildings. Melendy (23) emphasized strong reasons for large, square classrooms which are more adaptable to one-story structures.

All in all, there seemed to be no definite proof of the superiority of one-story or two-story schoolhouses. It might be stated, however, that the general trend is toward the one-story school plant wherever feasible.

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CHAPTER IX

School-Plant Operation, Maintenance, and Insurance

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IN THE February 1945 REVIEW OF EDUCATIONAL RESEARCH school-plant operation and insurance were discussed in separate chapters. The school-plant maintenance review was unavoidably omitted from that issue. This issue covers maintenance, operation, and insurance in one chapter. The section on maintenance includes a report of some studies on school-plant modernization and, to compensate for the maintenance chapters omitted from the 1945 issue, some maintenance studies completed prior to that date. The section on insurance includes a review of reported information in the closely related fields of fire hazards and fire prevention.

School-Plant Operation

During the war years greater use of the school plant increased the operating load. At the same time operating supplies were limited and many of the more able custodians and engineers were lost to the armed forces or to better paid jobs. Due to these and other causes, operating standards were lowered and the many administrative problems connected with plant operation programs increased in number and scope. These problems have been freely discussed but there has been only a limited amount of experimentation or research reported that would help the school administrator solve his operating problems. Even as late as the end of the year 1947 many administrators had not yet been able to rebuild competent custodial staffs or to overcome the effects of the poor operating practices of the war years.

Organization of Program

Various methods have been used to improve the morale of the custodial force and to develop a better working organization. Knoll (62) reported that improved personnel policies, such as the establishment of a merit plan with sick leave, vacation time, and employee retirement, paid big dividends. George (34) found a local custodial employee committee helpful in establishing policies, developing training procedures, and improving morale. Chipman (14) and Stoy (109) pointed out the importance of selection and training as factors in developing a competent custodial force. Cruickshank (20) indicated that one of the purposes of the Ohio Association of School Employees was the improvement of service to the schools. *School Life* (89) in a summary of school costs for the 1943-44 school year showed that for seventy-four small towns the plant operating costs averaged \$13.12 per pupil in average daily attendance. This was about 12 percent of the

average total cost per pupil. In these cities the operating costs ranged from 6 to 17 percent of the total costs per pupil.

Work Standards

There is a recognized need for better working conditions and improved work standards. The *School Executive* (86) outlined a suggested housekeeping checklist as one measure of operating efficiency. The Los Angeles Schools (66) developed in some detail a set of instructions and suggestions on housekeeping practices and procedures for various parts and areas of the building. Linn (65) listed careful selection, training, good supervision, and adequate tools and equipment as vital factors in economical custodial services. The Milwaukee Bureau of Plant Operation (72) outlined the essential steps in maintaining safe buildings and working conditions. To improve the New York City custodial service, Hynds (48) recommended a supervisory program, a reporting system, custodial ratings, inservice training, specific assignments, and cooperative committees.

The often-mentioned but still unsolved problem of work loads as factors in efficient and economical custodial service again received attention. From a survey of custodial services and plant operations, Smith (106) found a wide range of work loads. He listed building age and the type of fuel as two of the principal factors in determining work loads. He advised using square feet of floor space per minute as a unit of work load measurement. Huggett (44) reported less specialization, less supervision, and less standardization for custodial service in small towns. He recommended a daily schedule for each employee. Steen (108) reported satisfactory results with a work load schedule based on room cleaning equivalents. Thompson (112) reported that work loads were computed on various bases such as enrolments, number of rooms, and floor areas. She found that for the custodian work loads studied, 26 percent required a twelve-hour day, 39 percent a fifty-hour week. Sixty-five percent reported no definite work schedules.

Knoll (63) reported that with desirable incentives such as security, adequate wage scales, and suitable working conditions the morale of employees improved and fewer were lost to outside employment. Hynds (49) recommended the development of a plan for evaluating and recognizing custodial efficiency. He reported that with improved services the New York City school fuel bill was materially reduced. Daniels (21) stated that trained employees had been able to make a 50 percent reduction in certain repair costs.

Personnel Problems

When schools opened for the 1947-48 school year the *Nation's Schools* (76) reported some salary increases and more custodians available for employment. O'Keefe (78) stated in 1945 that only ten states or about 12 percent of the nonteaching school employees enjoyed the benefit of retirement laws. Both O'Keefe (78) and Clifford (16) felt that retirement

systems should be extended to cover the nonteaching employees. The lack of reported studies on the unionization of operating employees seemed significant. However, the *American School Board Journal* (3, 4) indicated that legal opinion generally is to the effect that unions of public employees have no status that might limit the authority of public bodies. It offered the opinion that boards of education are under no compulsion to recognize unions. It also stated that there is yet no one accepted policy covering schoolboard and employee union relationships.

Altho the need for trained custodians is pressing, many custodians still have no opportunity and little encouragement to participate in directed custodial training programs. Seagers (95) and Stoy (110) pointed out that custodial service in modern school buildings requires technical knowledge and skills that can best be developed with well-planned training programs. Various methods have been used in custodial training programs. Metcalfe (70) and the Industrial Sanitation Research Foundation (50) described the use of films and other visual aids as training media. Various training methods, including apprenticeship training, occasional classes, printed instructions, and schools organized with sequential courses leading to certification, were reported. Some of these schools were local and some were organized on a statewide basis. Putnam (80) stated that the school business managers should accept the responsibility for promoting and organizing custodial training programs. The Milwaukee (73) school officials developed an inservice program that combined printed instructions, class study, and supervisory advice on all phases of plant care, protection, and safety. Holubowicz (43) reported specific savings resulting from these programs. Sessions (97) reported a shortage of trained personnel and indicated that a legal opinion of the state's attorney general permits Ohio boards of education to pay the expenses of custodians attending training schools. Connecticut is one of the few states offering a statewide custodial program and Crouse (19) reported that the schools were set up for seventy-five hours of class instruction. The courses covered a wide range of subjects and completion led to a diploma. Kansas has one of the oldest, continuous, statewide training programs in the country. Winkel and Parker (127) reported that the effects of the programs were reflected in improved building care in the state's schools and in better morale of the custodial forces. Their report covered thirty-five janitor-engineer schools over a period of seventeen years with an aggregate attendance of over 3700.

Operating Procedures

The many reports made on operating procedures indicated a recognition of their importance, and of the problems involved. However, the lack of agreement on methods indicated a need for more research on plant operating procedures. Von Tungeln (122) pointed out the importance of floor sanitation in health protection, and Graban (38) stated that damp sweep-

ing makes for cleaner floors. Smalley (98, 99, 100, 101) warned against the use of oils on composition floors; advised the use of door mats to protect floor surfaces; stated that special attention must be given to the protection of waxed floors in winter time, and asserted that a proper base is essential before applying a surfacing material on concrete floors. Welch (124) recommended the use of tow mats in removing rubber burns. Barbour (10) concluded that custodians must know the principles of, and methods to be used in, floor care.

Some attention was given to operating practices in other areas. Whitaker (126) found that the promiscuous use of boiler compounds may be harmful to the heating system. Harris (39) urged use of the electro static process for cleaning the air in school buildings. Seagers (96) described various sanitary supplies needed in plant operation, while Hess (41) recommended a vermin eradication program, and Weed (123) found DDT valuable as an insecticide. George (35) reported that the life of window shades would be prolonged by trimming and rehangings. Kerrick (59) found that increased light and the removal of the sources of odors improved toilet sanitation. Bisel (12) urged that custodians give more attention to safety, and Milne (71) outlined recommended work procedures for the operating personnel. Kacel (58) stated that in industrial sanitation the first aim was to prevent the accumulation of dirt. He found that research in plant sanitation had been neglected. The Industrial Sanitation Research Foundation (51) prepared a worker's manual on sanitation and cleaning procedures.

School-Plant Maintenance

Planning the Maintenance Program

In too many cases maintenance neglect has led to rapid deterioration of the buildings. Viles (118) stated that maintenance programs should be planned on a scheduled basis, that the anticipated costs should be included in the annual budget, and that the custodians should be trained in maintenance procedures. Clark (15) found that maintenance tasks could be classed as major nonrecurring, urgent recurring, and recurring nonurgent. He recommended long-term budgeting for maintenance. Adequate financing and preventive maintenance on a scheduled basis was recommended by McGrath (68). Husband (45) discussed the value of a schedule in maintenance, Du Frain and McGrath (23) pointed out the difficulties in wartime maintenance, and *School Management* (91) summarized a forty-one point summer maintenance program for one city.

School Life (89) reported that for 1943-44 the average maintenance costs were four dollars per pupil in average daily attendance in the schools of seventy-four small cities. This was a little less than 4 percent of the total average cost per pupil. The annual maintenance costs ranged from

less than fifty cents to nearly twenty-eight dollars per pupil, or in percent terms from $\frac{1}{2}$ of 1 percent to more than 18 percent of the total average cost per pupil. Preventive maintenance and an ample budget allowance were recommended by Johnson (53, 55). He recommended the development of an adequate maintenance shop, well-equipped and well-manned. Saunders (83) proposed weekly inspections of all buildings, current repairs as needed, with more extensive summer programs. George (33) pointed out the importance of complete current inventories as a factor in total property upkeep. *School Management* (92) reported excellent results in a California high school from a student's maintenance committee organized to aid in plant preservation.

Engelhardt (26) reported reduction in the incidence of disease and improved attendance resulting from air sterilization of school buildings. However, he made no recommendations pending further experimentation in this area. Gallistel and Peterson (31) advised complete heating repairs during the summer. They recommended that all ducts and tunnels be cleaned. Schmidt (84) stated that poor maintenance leads to lowered efficiency for heating, ventilating, and lighting systems. Raddar (81) found that nine out of ten schools could reduce costs and improve heating services by proper maintenance of radiator traps, checking vents, repairing the chimneys, and by the general overhauling of the whole heating system. Frostic (30) recommended that furnace rooms be cleaned up and then painted so that they may be more easily maintained. McCarty (67) outlined certain procedures in maintaining toilet rooms.

Maintenance and Rehabilitation

While modernization and rehabilitation may be classified as capital outlay or remodeling programs their relationship to current maintenance justifies the inclusion here of recent studies and reports on plant rehabilitation. Since most schools cannot erect now all of the new facilities desired there is reason to give attention to maintenance and rehabilitation needs and possibilities.

Viles (116) reported from a study of 327 buildings that 150 needed major heating plant improvements, and that 130 needed improvements in the ventilating system. He found lighting and plumbing facilities in a majority of the buildings in need of repair or replacement. Exit facilities also needed to be improved. He also set up an eight-point criteria to help solve the problem of when to abandon or when to remodel a building. Kierman (60) advised that existing buildings be re-examined to determine whether they might be retained in use if rehabilitated and properly maintained. Hauser (40) pointed out that lighting facilities, plumbing, decoration, and fire-safety features deteriorate rapidly and need frequent attention. Starin (107) listed mechanical systems repairs as factors in a remodeling program. The *American School Board Journal* (6) stated that it

is desirable to make essential repairs even if the new construction program must be delayed. *Nation's Schools* (77) listed various repairs and improvements necessary to improve safety conditions in the buildings. Schwarz (94), Best (11), and McMurry (69) discussed methods of obtaining better sound control in the buildings. Irons (52) reported that life, health safety, and functional adequacy were used as criteria for evaluating old buildings. The *Elementary School Journal* (25) stated that because of heavy wartime use of school plants the federal government should now help finance the repair and rehabilitation programs.

Maintenance of Sites

The improvement of school playground surfaces continued to receive much attention. Schotland (93) in reporting on the results of several years of experimentation with gravel, sod, crushed stone, concrete, and other methods of playground surfacing stated that he had found asphalt-cork and hot asphalt on dirt best suited to his needs. Fetherston (28) reported that cold asphalt and dirt mixtures were providing acceptable and economical playground surfaces. Hoek (42) also reported good results with asphalt surfacing. Lentz (64) described lawn maintenance procedures. Viles (117) reported that proper maintenance improved safety conditions on the playground. Bailey (9) outlined a cooperative school and community plan for the maintenance of grounds.

There was much interest in the rejuvenation and maintenance of floors. Glanzer (37) reported that a new impregnation process adapts soft woods for floor use. Smalley (102, 103, 104, 105) reported that wax substitutes have not proved satisfactory and outlined methods for refinishing old oiled floors, for the removal of rubber burns, and for summer floor rejuvenation. The *School Executive* (88) stated that asphalt tile floors should be waxed at least three times a year.

There were a limited number of studies reported on other maintenance needs and procedures. The *American School Board Journal* (7) described the need for and procedures to be used in waterproofing certain types of walls. Welch (124) outlined roof repair procedures. Corbitt (18) found preventive maintenance for school equipment economical, and Telford (111) reported that adequate maintenance materially improved safety conditions in the school. Townsend (114) reported satisfying results from an experiment with a multiple color scheme for classrooms. Browne (13) outlined criteria for paint selection. *Hygeia* (47) recommended changes in the care of room lighting, and Allphin (2) found that regular maintenance reduced current cost and increased lighting efficiency.

Property Insurance

Research on insurance practices in the 1945-1948 period was limited. However, building values continued to increase and insurance undercover-

age was common. The *School Executive* (87) reported that coverage was far below current insurable values. Joyner (56, 57) reported that increasing values created a demand for more coverage and developed a seller's market for insurance. He also reported much undercoverage and recommended that school officials develop and maintain current evaluations for all property to be protected by insurance. Pattington (79) stated that while self-insurance may be feasible for large districts it is not practical for the smaller school districts. Garvey (32) described the procedures followed in establishing a continuing insurance program for Oak Park, Illinois. The *American School Board Journal* (5) found that better school-plant management and possible rate reductions would aid in decreasing insurance costs. It recommended six major areas in which improvements are needed in the local insurance program. Viles (120) reported that insurance costs could be reduced as much as 30 percent on nonfire-resistive and about 75 percent on fire-resistive buildings by use of co-insurance contracts. He recommended that insurable values be computed as current replacement costs, less depreciation, less allowable exclusions.

Fire losses and fire prevention are closely related to property insurance and in these areas there was more activity. The outstanding activity in this field was The President's Fire Prevention Conference in 1947 which brought together about 2000 of the nation's leading authorities in insurance and fire protection. The report of the Committee on Fire Prevention Education (29) stressed the obligation of all school officials and employees to help maintain fire-safe conditions in the schools. It recommended state department of education participation and leadership in maintaining fire safety in school buildings. Colt (17) recommended sprinkler systems for school buildings. Hutson (46) found 2 percent of fires were responsible for 70 percent of property loss. Kimball (61) reported an increasing frequency of school fires. He cited electrical hazards, smoking, incendiarism, and heating equipment as the most common causes of school fires. *School Management* (90) listed similar hazards, and the National Fire Protection Association (75) reported a total loss of 807 lives since 1908 in school fires.

Viles (119, 120) stated that the continued presence of fire hazards in a school building denotes inexcusable ignorance or carelessness. He pointed out numerous structural and operational hazards that should be corrected. He urged that more attention be given to evacuation procedures. Essex (27) stated that masonry walls do not make a fire-proof building. He listed fire prevention, checking and spread of fires, and evacuation as protective measures. The Safety Research Institute (82) listed the principal sources of information on fire safety. Easton (24) and Downs (22) recommended the installation of fire doors and sprinkler systems and Bacon (8) pointed out the importance of having the right type of fire extinguishers. The Milwaukee Public Schools (74) have prepared and are using a detailed inspection form in checking school fire safety.

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CHAPTER X

Financing the School Plant

WILLIAM R. FLESHER

THE importance of money in the development of school-building programs has become increasingly evident in the issues dealing with school plant in the last five cycles of the REVIEW OF EDUCATIONAL RESEARCH. The organization of material regarding this aspect of the school plant in the present issue follows quite closely that followed in the fifth cycle (13).

The triennium since 1944 has seen relatively little actual research in the area of financing school-plant construction. The period has been characterized, however, by a great amount of planning for future construction. This is a healthful emphasis in that careful, long-range planning tends toward wiser expenditure of money. There seems also to be a developing trend in the use by boards of education and superintendents of schools of the services of outside consultants in the field of school-plant planning. School staffs generally cooperate in this procedure.

There appear to be other developments with certain financial implications in school-building planning. School-survey services are being inaugurated by several state universities and teachers colleges. The institutions already providing this type of service have had increasing numbers of calls for survey work, particularly in the field of school buildings. Flesher (12) indicated the growing demand for the services of one such agency.

The period of economic prosperity during and following World War II has induced school districts to seek approval of many bond issues for capital outlay. Prevailing low-interest rates have been conducive to this activity. Existing high building costs have led many school districts, on the other hand, to be hesitant in asking for bids and in letting contracts. Many districts which have secured approval of bond issues have sold their bonds to take advantage of low-interest rates and have invested the money in some type of short-term investment, awaiting the day when a reduction in building costs will make it possible for them to go ahead with construction within their financial limits.

Many school districts are hopefully expecting some type of federal aid for new school plants. Some writers, Thurston (29), for example, in the field of school and government finance predict, however, that federal aid of this kind will be made available only in case of general unemployment.

School-Building Needs

Estimates of the backlog of needed school-building construction continued to vary appreciably but in all cases were relatively large. Hamon (14) pointed out that the per-pupil value of existing public-school plants

ranges from \$103 to \$670 among the different states, with a national average of \$371. He concluded that an over-all school-plant value of \$500 per pupil should constitute a minimum goal in the postwar era, or an increase of \$129 per pupil above the present average. To raise the school-plant value to the level of \$500 per pupil would require \$3.2 billions. On the same per-pupil basis an additional \$2.5 billions would be required to provide adequate housing for the five million children of school age who are not in school. Hamon estimated further that only about \$800 million would be spent from 1941 to 1947 and that from 1948 thru 1952 \$2.4 billion will need to be expended to bring the school-plant value to a \$500 average per pupil for those children now in school.

Thurston (29) in 1947 estimated a national need for approximately \$6 billion for school plants and an additional \$2 billion to make our school buildings "absolutely safe" and "places of comfortable and efficient habitation."

Lewis (19) estimated a need of \$2.5 billion for the five-year period following the end of the war. On the basis of a questionnaire study made in 1944 by the American Association of School Administrators, Cocking (8) estimated the cost to meet the public-school building needs of the nation to be approximately \$2 billion, exclusive of rural and consolidated school districts, where the need is probably greatest.

Efforts to meet school-plant needs have not been lacking. Table I, compiled by the writer from *Bruce's School Market Letter* (3), presents certain data relative to the extent of building contracts let from 1944 thru 1946 and the school bond sales during the same period.

TABLE I.—SCHOOL BONDS SOLD AND SCHOOL-BUILDING CONTRACTS LET, 1944 THRU 1946

Year	School bond sales	Contracts let		
		Number of projects	Square feet	Value
1944.....	\$ 51,224,600	3,305	11,080,000	\$ 72,683,000
1945.....	131,369,940	2,209	13,753,000	112,347,000
1946.....	264,182,810	2,234	25,609,000	212,729,000

Building Cost Indexes

Williams (30) computed the 1945 building-cost index for the New York area to be 157.1 on the basis of the 1926-1929 average of 100. Using the average for 1935-1939 as the base, Clark (7) computed the index for February 1947, as 165. He pointed out that since 1939 the cost of school-

building materials and labor had risen 65 percent, whereas construction costs had increased 105 percent.

The *Architectural Record* (1) computed percents of increase in construction-cost indexes as of October 1947, for four metropolitan areas in the nation. The percents are as follows and represent increases since 1939:

City	Percent
Atlanta	73.5
New York	67.1
St. Louis	61.9
San Francisco	61.4

The above figures were prepared by the F. W. Dodge Corporation from data compiled by E. H. Boeckh and Associates, Incorporated.

Essex (11) compared school-building costs of fifty years ago with current costs. He estimated that for identical communities the volume of a school building was now four times as great as a half century ago. He estimated further that in 1945 a new building would cost ten times as much as a similar building did in 1895.

Bartels (2) computed for the city of Cincinnati indexes of total cost of construction which reflected not only the cost of construction but also interest payments on bonds issued to pay for such construction. Altho the data are local, the technic employed is valuable. The formula used by Bartels is: Index of total cost = Index of construction cost \times (1 + interest rate per unit period \times number of interest periods + 1.) He found that from 1921 to March 1947, the index of construction cost rose 74 percent, whereas the index of total cost rose only 19 percent. This difference is a reflection of decreasing interest rates which have tended to offset increases in construction costs. Bartels's data showed an increase of 90 percent for construction cost from a low in 1932 to a high in 1946 and an increase of only 55 percent in the index of total cost of construction (including interest) for the same period.

Division of Costs

Rosenstengel (27) gave the following as approximate divisions among the four major cost categories in school-building construction: general construction, 80 percent; heating and ventilating, 10 percent; plumbing, 6 percent; electrical work, 4 percent. Engelhardt (10) gave the following as the averages for eleven school-building projects in New York City: general construction, 77 percent; heating and ventilating, 12 percent; plumbing and drainage, 5 percent; electrical and fixtures, 6 percent. The latter figures are essentially the same as those found by Coons and Essex (9) in their analysis of the construction costs of 124 buildings.

Engelhardt (10) compared 1940 cost estimates for eleven projects in

New York City (five additions and six new structures) with low bids for these projects in 1946-47. The average percents of the excess of bids over estimates are:

General Construction	105
Heating and ventilating	80
Electrical and fixtures	75
Plumbing and drainage	54

Methods of Financing

The sale of school bonds continued to be the major source of revenue for the construction of school buildings. Since 1944 the sale of bonds has increased rapidly (see Table I). The amount of bonds sold in 1945 was an increase of 156 percent over the total in 1944. In 1946 the amount was approximately double that sold in 1945. Mulford (21) offered helpful suggestions regarding the issuance of school bonds for capital outlay.

Clark (6) pointed out that interest rates had declined from 1929 to 1946; but that in 1947 they had started to rise as indicated by a net average rate in July 1947, of 2.61 percent and a net average of 2.77 in August 1947. Thurston (28) pointed out the inequities existing between the assessed valuation and the real value of taxable property thruout the nation. He stated that in 1938 the estimated value of property in the United States was approximately \$310 billion, whereas the assessed value was approximately \$140 billion. He also emphasized the fact that altho national income had increased phenomenally, the assessed value of taxable property had not begun to keep pace but had, in fact, actually declined in many instances.

Peterson (24) and Rosenfield (26) emphasized the deleterious effects of legal restrictions imposed in most states with respect to financing capital outlay and particularly regarding the creation of school-building reserves.

Rosenstengel (27) suggested the following as a plan in budgeting for school-plant improvement: cost of bond issue, 1 percent; survey and consultants, 1 percent; site, 10 percent; selection of architect, .3 percent; architect's fees, 6 percent; building construction, 65.4 percent; educational equipment, 7.3 percent; landscaping, 7 percent; miscellaneous, 2 percent. Hamon (15) proposed the following as a budget of expenditures: land and site improvement, 10 percent; professional services, 5 percent; furniture, 10 percent; general construction, 55 percent; heating and ventilating, 12 percent; plumbing, 4 percent; electrical work, 4 percent.

State and Federal Aid

Lewis (19) suggested that school buildings be financed jointly by local, state, and federal money, the money to be divided as follows: federal, 50 percent; state, 25 percent; local, 25 percent. He supported the high percent of federal support by the statement that the federal government had

pre-empted the best sources of revenue. Lindman (20) suggested the following formula for apportioning aid in the state of Washington:

$$\text{Percent state aid} = \frac{200,000 \times \text{number of classroom units} - \text{valuation}}{200,000 \times \text{number of classroom units} + \text{valuation}}$$

He pointed out that this formula combines the principle of equalization with the principle of matching. In terms of the formula the state would provide, on an average, 40 percent of the cost of construction. The range of state aid would be from 25 percent for a valuation of \$120,000 per classroom unit to 73.9 percent for a valuation of \$30,000 per classroom unit. Hamon (15), Johns (18), and Clapp (5) stressed the necessity for equalization in state and federal aid for capital outlay. Johns (18) pointed out that matching and flat grants per pupil were generally unsound bases. Hamon (16) stated that as of December 1945, only the following sixteen states had provided state funds for school-plant construction: Alabama, Connecticut, Delaware, Georgia, Minnesota, Missouri, New York, North Carolina, Ohio, Oklahoma, Rhode Island, South Dakota, Utah, Vermont, Virginia, and Washington.

Cate (4) reported that thru June 1942, school plants constructed under the WPA cost approximately \$448 million, of which the federal government provided \$314 million. Under PWA during the same period school-building construction amounted to \$1,179,000, of which 45 percent was federal funds. He reported also that \$142 million had been expended under the Lanham (Community Facilities) Act, with the federal government providing \$66 million.

On the basis of a questionnaire survey, Hewes (17) reported data concerning school-building planning and the aid given by the federal government in this planning. Details are shown in Table II.

TABLE II.—PLANNING FOR NEW SCHOOL-PLANT CONSTRUCTION

Category	Projects	
	Number	Estimated cost
Federal planning advances approved.....	1,793	\$ 359,513,000
Application for federal advances under review.....	1,034	272,242,000
Plans completed without federal assistance.....	1,278	276,217,000
Plans in design stage without federal assistance.....	2,486	891,253,000
Total.....	6,591	\$1,799,225,000

Bruce's School Market Letter (3) presented a compilation in January 1947, regarding FWA funds for school-building planning since June 1946. The results are shown in Table III.

TABLE III.—FWA ADVANCES FOR SCHOOL-BUILDING
PLANNING SINCE JUNE 1946

Type of building	Federal advance	Number of school projects	Estimated cost
Elementary schools.....	\$1,125,803	207	\$ 32,096,418
High schools and junior high schools.....	2,208,233	193	70,577,705
Colleges and universities.....	264,456	20	8,240,807
Stadiums, athletic fields, and swimming pools.....	47,200	9	1,034,947
Teachers' residences.....	2,040	3	55,083
Combination grade-high schools.....	16,500	4	468,530
Consolidated schools.....	46,600	4	1,275,436
Total.....	\$3,710,832	440	\$113,738,926

Publicity for School Financial Support

Since 1944 at least three publications dealing with school campaigns for financial support have come to the writer's attention. Of the three, Reeder (25) provided the most extensive treatment. The other two documents published by the National School Service Institute (22) and the Ohio Education Association (23) are primarily manuals for conducting publicity campaigns. Each presented much illustrative material. The value of continuous school publicity continued to be stressed by writers in this field.

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Index to Volume XVIII, No. 1

Page citations are made to single pages; these are often the beginning of a chapter, section, or running discussion dealing with the topic.

- Acoustics, 6
- Air-borne infection, 39
- Boiler efficiency, 55
- Bonded debt, 65
- Bonds, 65, 67
- Brightness balance, 35
- Budgeting, for school plant improvements, 67
- Building costs, indexes, 66
- Cities, school building for, 16
- Classrooms, design, 22; elementary, 22; size and shape, 22, 23
- Codes, school plant, 6
- Color, and lighting, 33
- Community Facilities Act, 68
- Community needs, for school plant, 6
- Community use, of school plants, 28
- Concrete, use for school plants, 46
- Construction costs, 66
- Cost indexes, school plant, 65
- Costs, of plant construction, 66; of school plant, 65
- Custodians, organization, 52; training programs, 54; work standards 55
- Daylighting, 32
- Debt limitations, for school plants, 67
- Design, trends, 46
- Elementary schools, 22
- Enrolment, prediction, 14
- Equipment, for elementary classrooms, 23; school, 7
- Federal aid, for school plants, 67
- Federal Works Agency, 68
- Fire, insurance, 58; losses, 58; prevention, 58; protection, 8
- Floors, maintenance, 54
- Food service and preservation, 29
- Furniture, school, 7
- Glass block, 32, 45
- Health, and ventilation, 40
- Heating, 8, 37; radiant, 38; trends, 41
- Indexes, of school-plant costs, 65
- Insurance, 8; of school plants, 10, 57
- Interest rates, on bonds, 67
- Janitors, *see* custodians
- Lanham Act, 68
- Lighting, 9, 32; brightness ratios, 33; principles, 34; trends, 35
- Luminaire brightness, 35
- Maintenance, of floors, 54; of school plants, 9, 55; of sites, 57
- Material and design, school plant, 44
- Materials, school plant, 45
- Modernization, of school plants, 56
- Multiple use, of school plants, 48
- Need, determination, for school plant, 15, 64
- Needed research, on school plant, 5
- Neighborhood primary schools, 30
- Operation, school plant, 52
- Panel heating, 38
- Personnel, custodial, 53
- Philosophy, of planning schools, 13
- Planning, philosophy of, 13; procedures, 16
- Planning procedures, factors involved, 18; for city schools, 16; in state departments, 17
- Plastics, 45
- Playgrounds, 57
- Plywood, 46
- Population prediction, 14
- Prediction, of enrolments, 14
- Prefabricated buildings, 45
- Primary school plant, 30
- Publicity, and school support, 69
- Records and reports, 10
- Recreation, and school plant, 29
- Refrigeration, reverse cycle, 41
- Rehabilitation, of school plants, 56

Sanitary facilities, 37, 41

School plant, codes, 6; community use, 6, 28; federal and state aid, 67; financial aspects, 6, 64; functional planning, 7; insurance, 8, 57; maintenance, 55; material and design, 44; multiple use, 48; needs, 64; operation, 52; personnel problems, 53; recreational use, 29

Sites, 10; maintenance, 57

State aid, for school plants, 67

Surveys, school plant, 13, 64

Technics, survey, 13

Thermal balance, 40

Toilet facilities, 10, 24

Ultra-violet radiation, 39

Unit ventilation, 41

Ventilation, 8, 37; trends, 41

Work standards, for custodians, 55